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DEFORMATION OF A BICRYSTAL WITH STRAIN GRADIENT EFFECTS*

John Y. Shu
L-370, Chemistry and Materials Science Department, Lawrence Livermore National Laboratory, Livermore, CA 94550
jyshu@llnl.gov

Norman A. Fleck
Cambridge University Engineering Department, Trumpington Street, Cambridge, CB2 1PZ, U.K.
naf1@club.eng.cam.ac.uk

Wayne E. King
L-356, Chemistry and Materials Science Department, Lawrence Livermore National Laboratory, Livermore, CA 94550
weking@llnl.gov

The boundary between two single crystal grains plays a very important role in determining the deformation of the bicrystal. This work addresses the role of a perfectly bonded grain boundary by considering the effect of strain gradients on the hardening of slip systems. A new crystal plasticity theory recently developed by Fleck and Hutchinson is implemented within the framework of the finite element method using novel finite elements suitable for strain gradient solids. The Fleck-Hutchinson crystal theory is based on the notion of elevated hardening due to geometrically necessary dislocations. The strain and lattice rotation distribution in a model planar bicrystal with two slip systems is obtained. The bicrystal consists of two single crystals of half plane and is subjected to nominally uniform tension and shear loading. In contrast with conventional crystal plasticity predictions, it is found that there is a boundary layer around the interface where non-uniform deformation occurs. The width of the boundary layer is determined by the misorientation of the lattices, the hardening behavior of the slip systems, and is linked to a characteristic material length scale.

Key: Strain gradient crystal plasticity
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